AtmoHEAD

Atmospheric Monitoring for High-energy Astroparticle Detectors

Overview of the field & prospects for the near future
Wrap-up of 2013 workshop

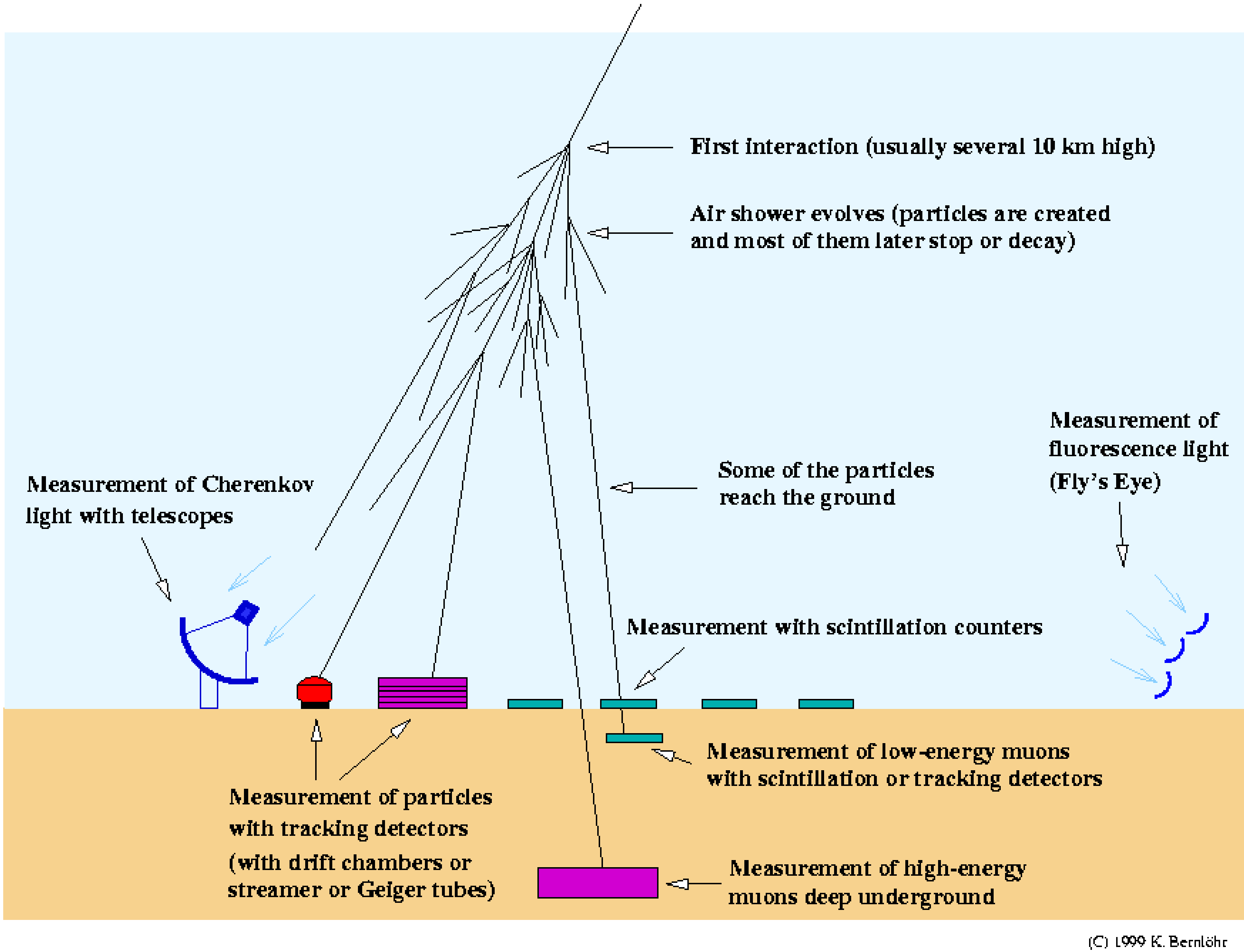
Colloque PNHE Grands Instruments
2-3 April 2014, Paris

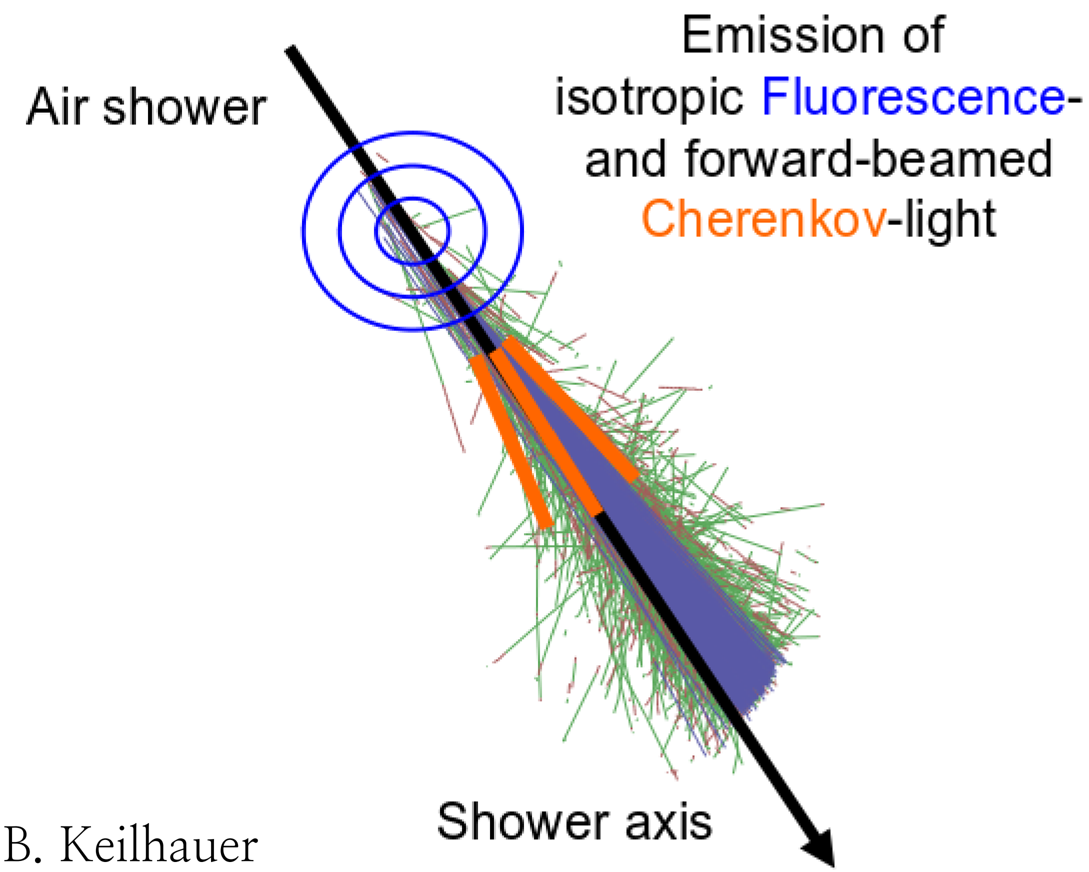
Ryan C. G. CHAVES
Marie Curie Fellow, LUPM

Why do we care about the atmosphere?

Our calorimeter

also the medium through which produced photons propagate





B. Keilhauer

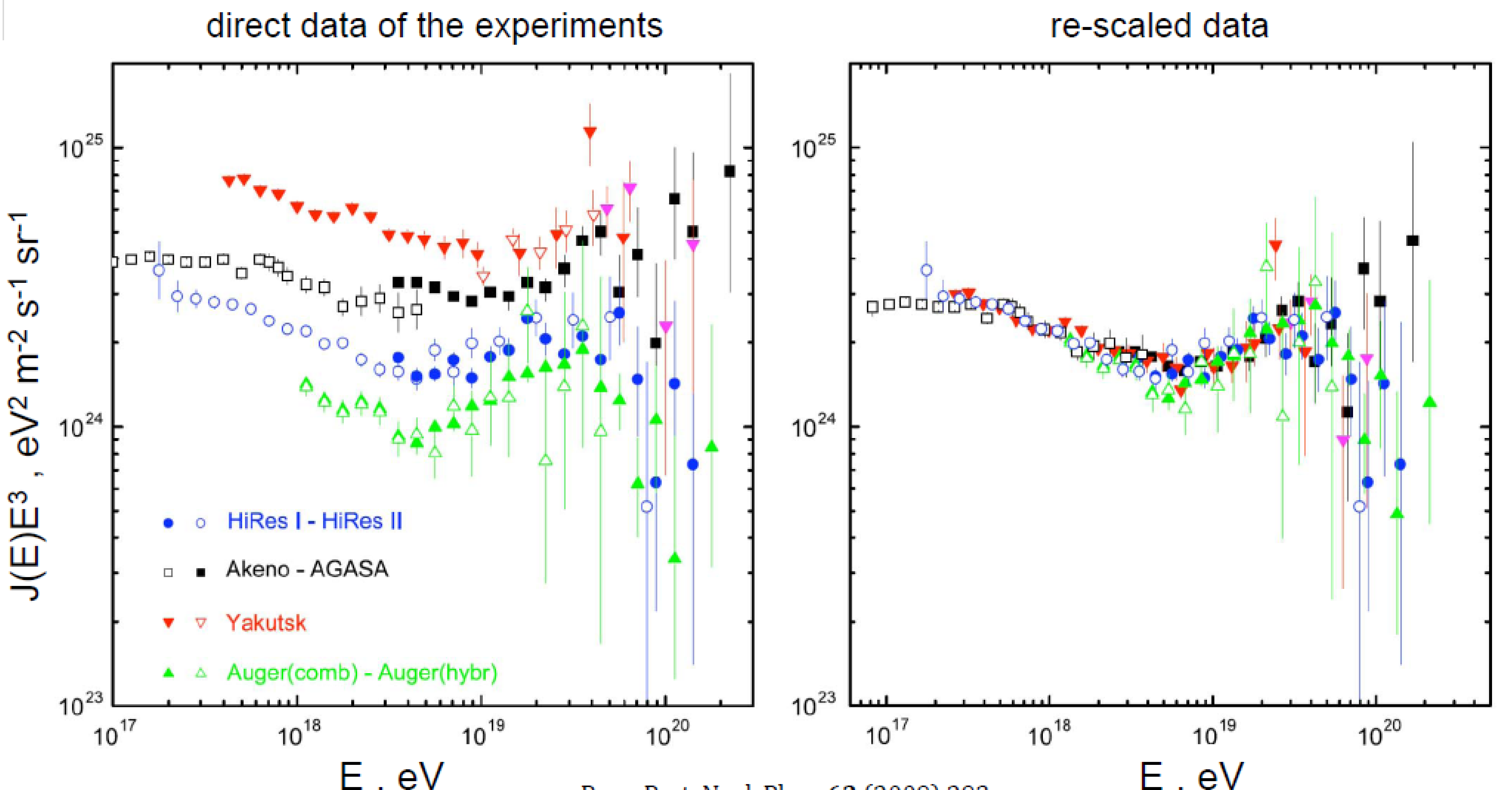
Fluorescence

Photon yield very sensitive to humidity, density, temperature

Cherenkov

Yield & shower image primarily sensitive to clouds & aerosols (haze, dust, smoke)

Atmospheric calibration critical for EAS observatories



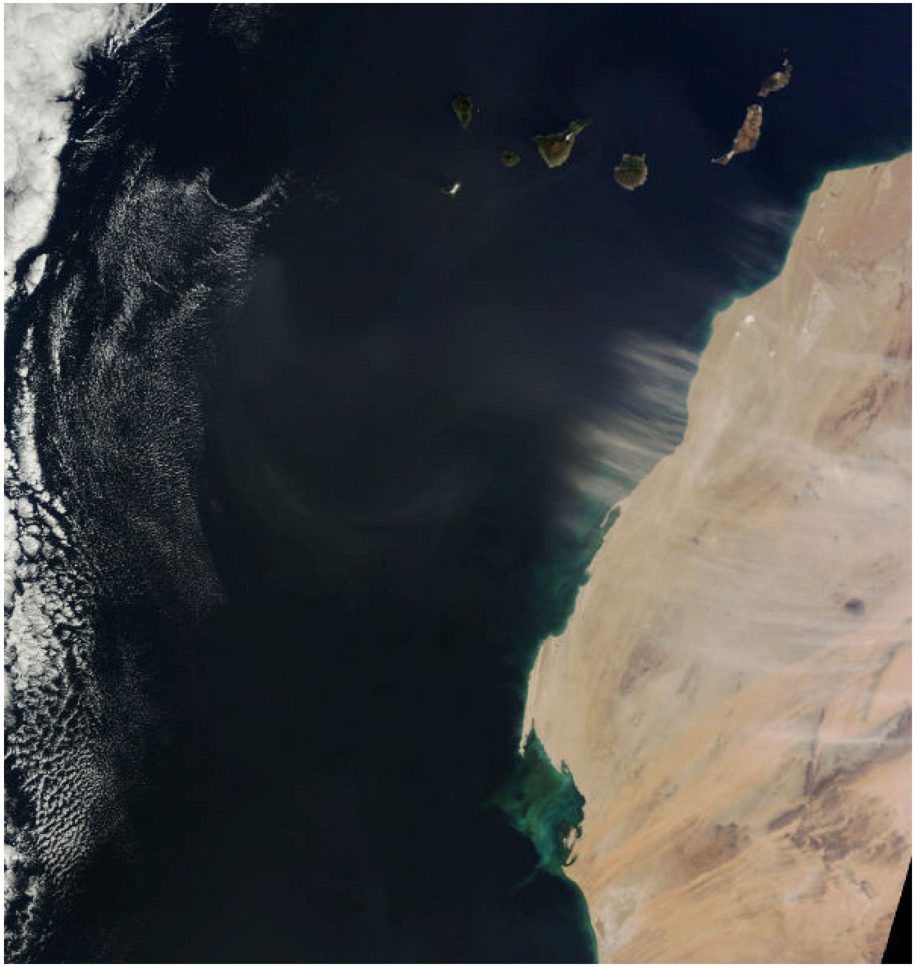
Prog. Part. Nucl. Phys. **63** (2009) 293

Why do we need to monitor the atmosphere?

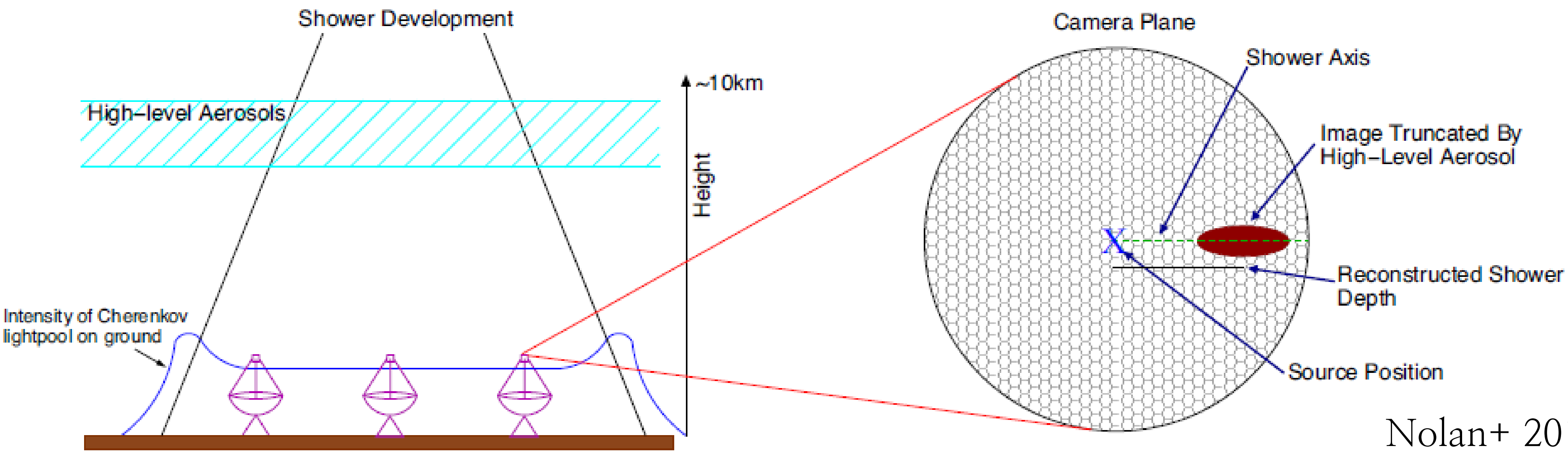
Why do we need to monitor the atmosphere?

Biomass burning

Dust storms

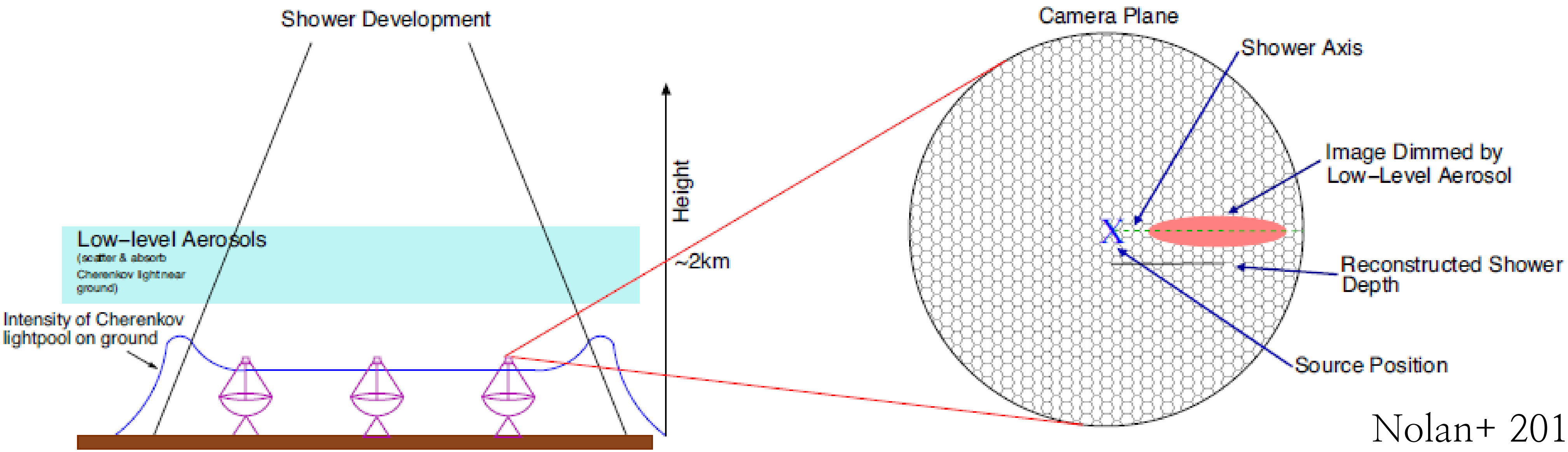


High−altitude aerosols occur near shower maximum
Affect EAS shape & Cherenkov yield



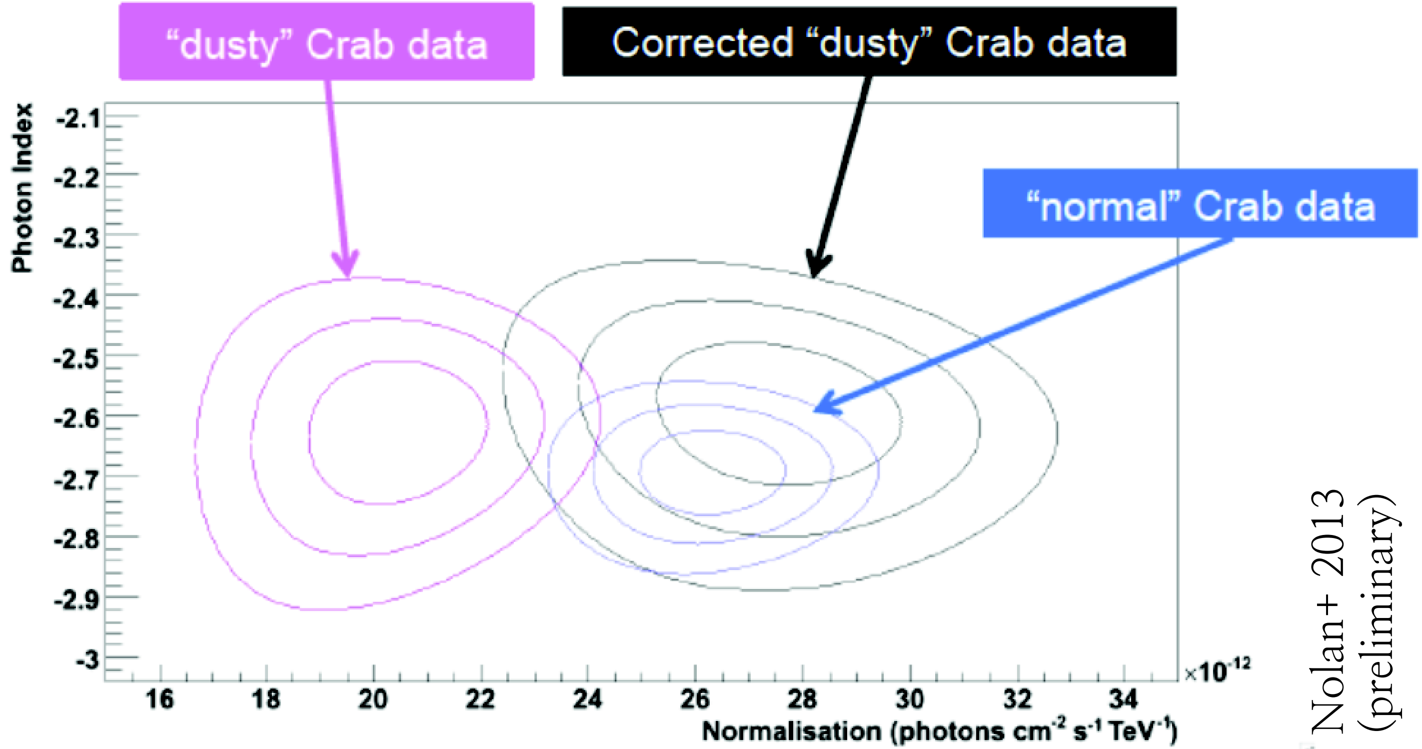
Nolan+ 2011

Low−altitude aerosols occur near ground
Reduce Cherenkov yield

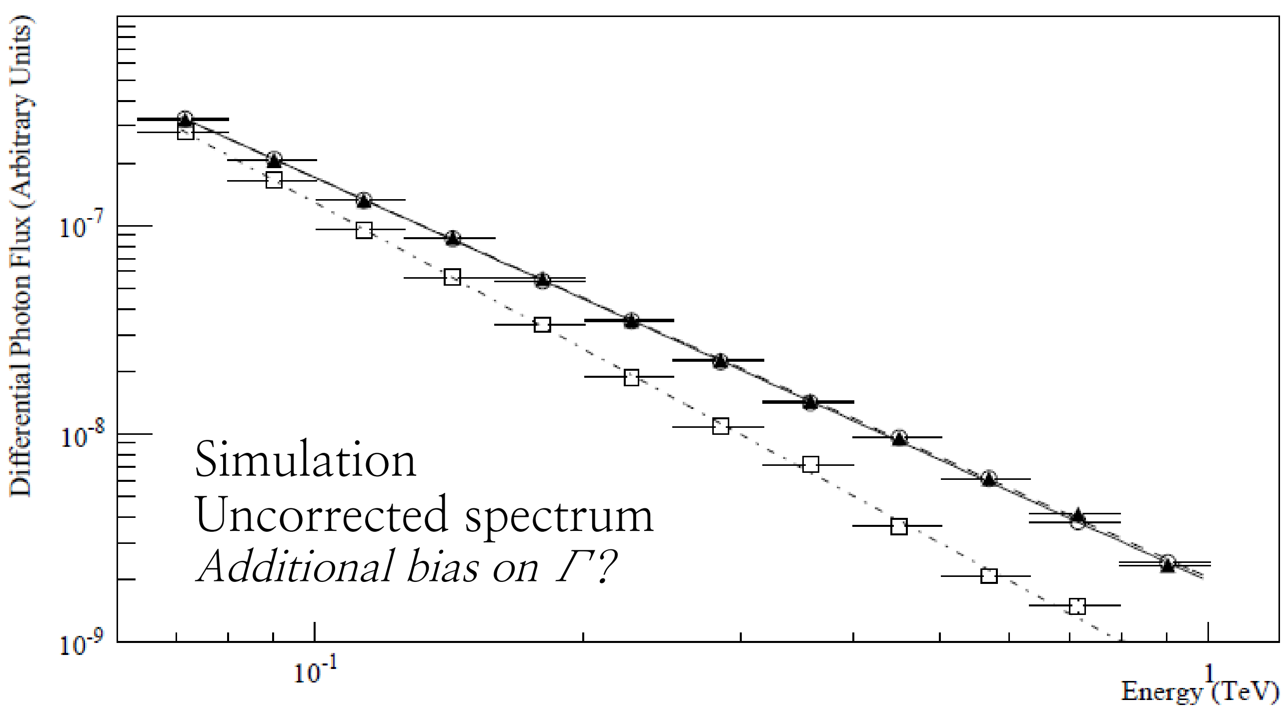


Nolan+ 2011

Lower EAS trigger rates (up to 50%)
Fainter camera images → some low−E showers too faint to trigger
Biased effective area
Worsened energy resolution



Nolan+ 2013
(preliminary)



CTA Consortium 2010

How can we deal with atmospheric uncertainties?

“Correcting” IACT data (current technique)

1. Throw away data that doesn't pass atmosphere quality cuts; accept ~20% systematic errors

Correcting IACT data w/ atmospheric monitoring

Monitoring techniques

radiosonde balloons
weather stations
cloud/IR cameras
LIDARs
satellites

Correcting IACT data w/ LIDAR monitoring

1. Measure vertical density (optical depth) profile of atmosphere/calorimeter for each observation run

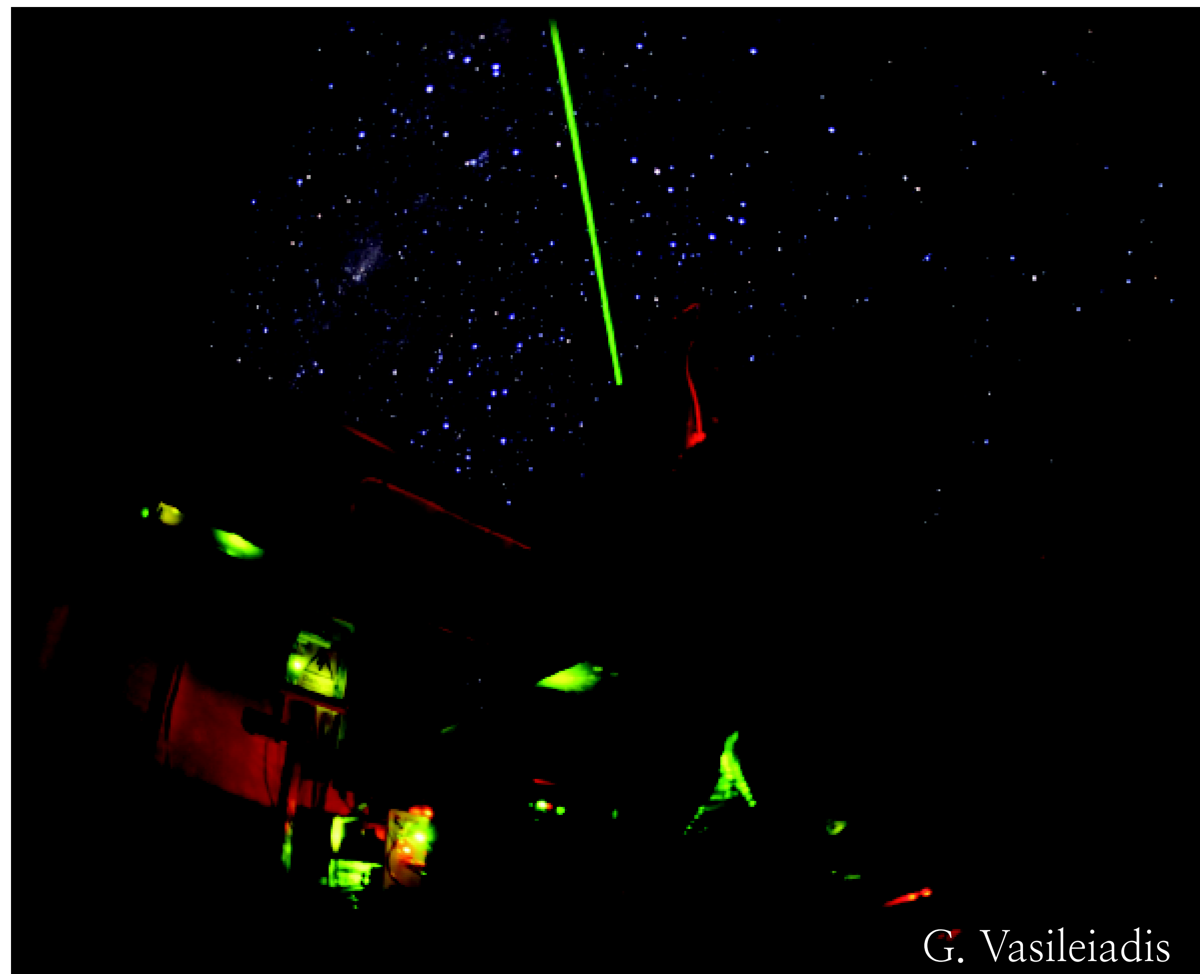
2. Extract extinction coefficient α

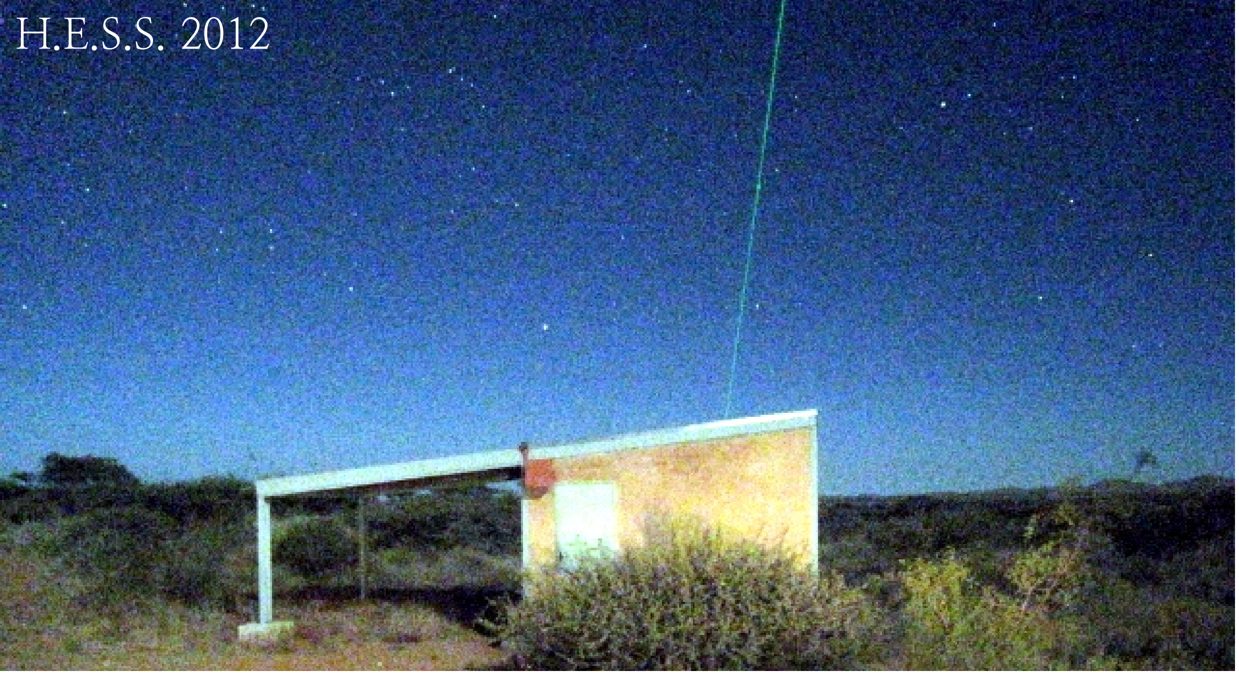
3. Compute MC simulations for different α to create templates

4. Match each run with an atmospheric template

5. Enjoy improved systematics & increased duty cycle (via smart scheduling)

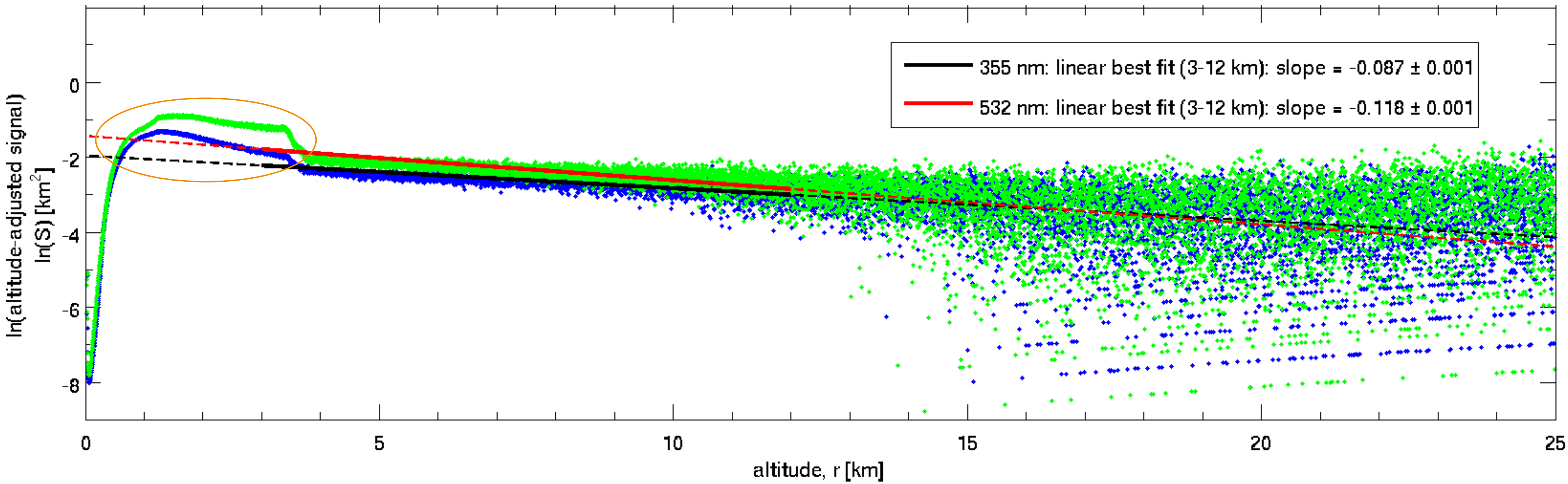
H.E.S.S.



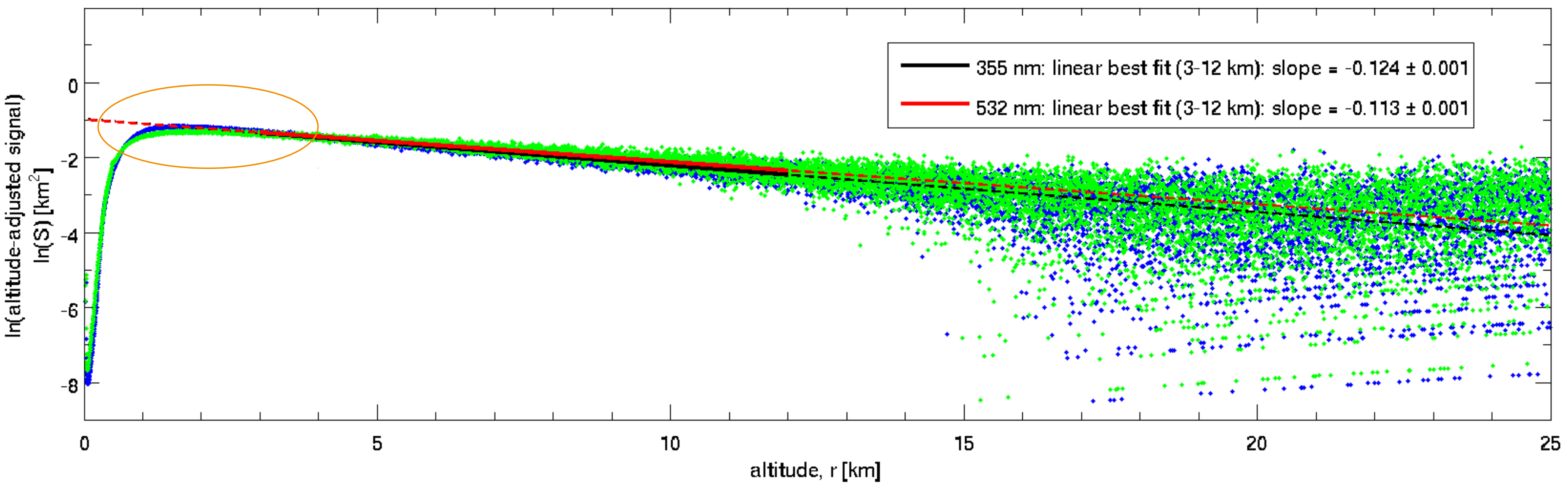


Montpellier LIDAR on H.E.S.S. Site

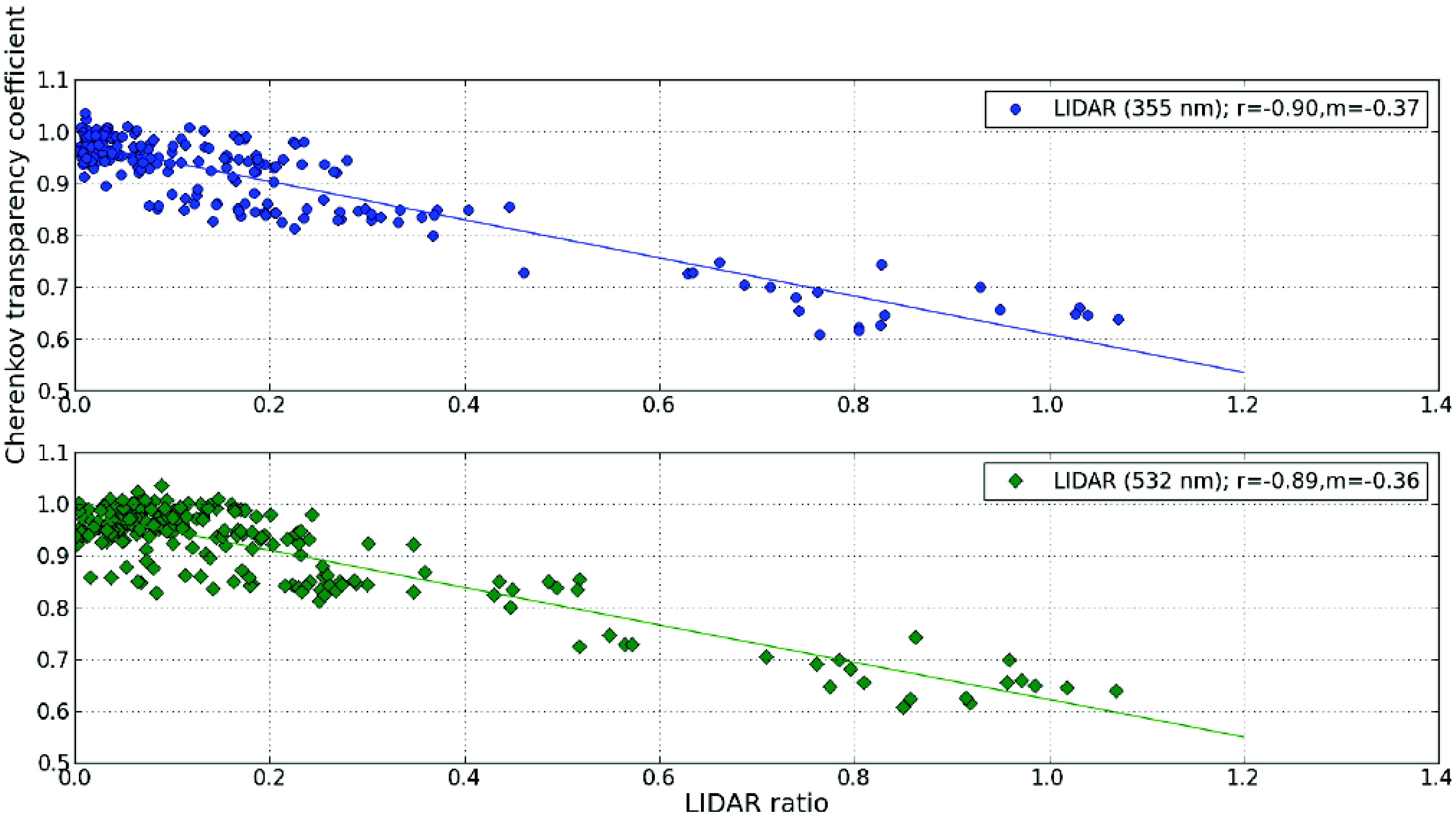
installed in 2009
dual wavelength: 532 nm / 355 nm
850 m from Cherenkov telescopes in dedicated hut
inhibit mode: operated in between telescope observations
fast & efficient: atmospheric profile in < 90 s

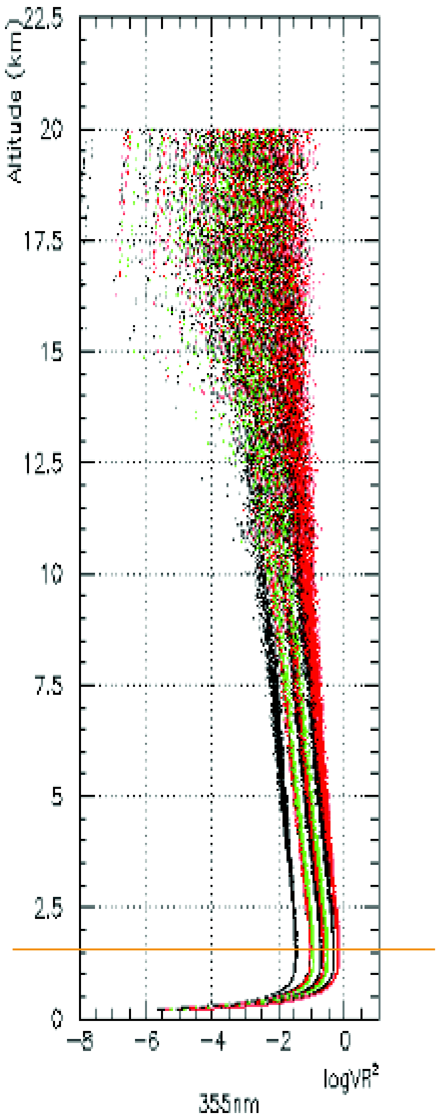


Sample LIDAR profiles: aerosols present vs. clear night



LIDAR **validation** via correlation with *Cherenkov transparency coefficient* = f(trigger rate, ...)

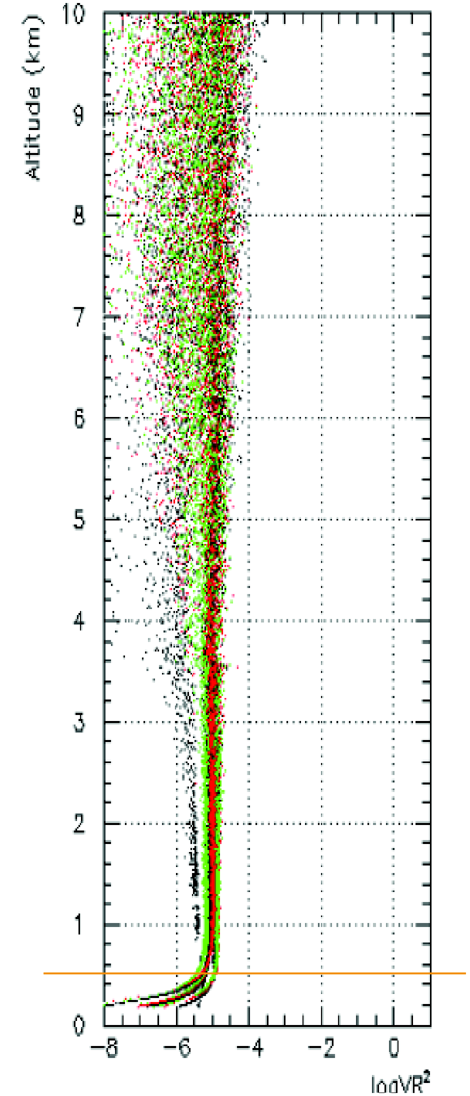




bi−axial

~April 2013 mounting conversion

reduced altitude threshold
1.5 km → 0.6 km



co−axial

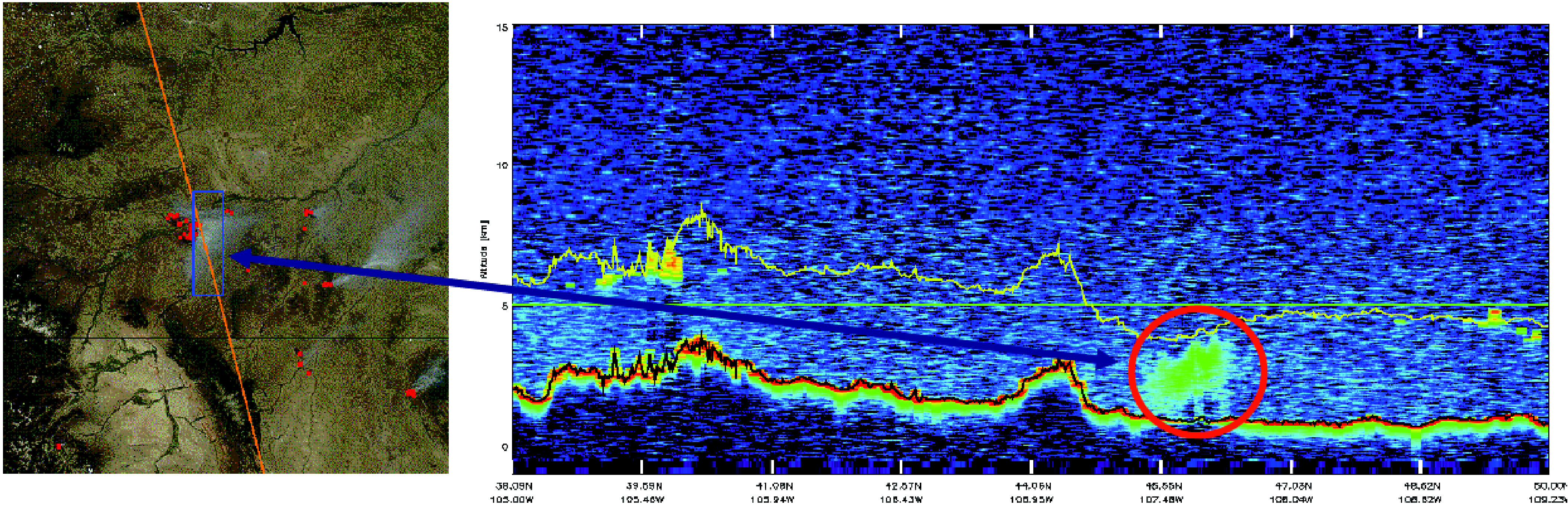
G. Vasileiadis

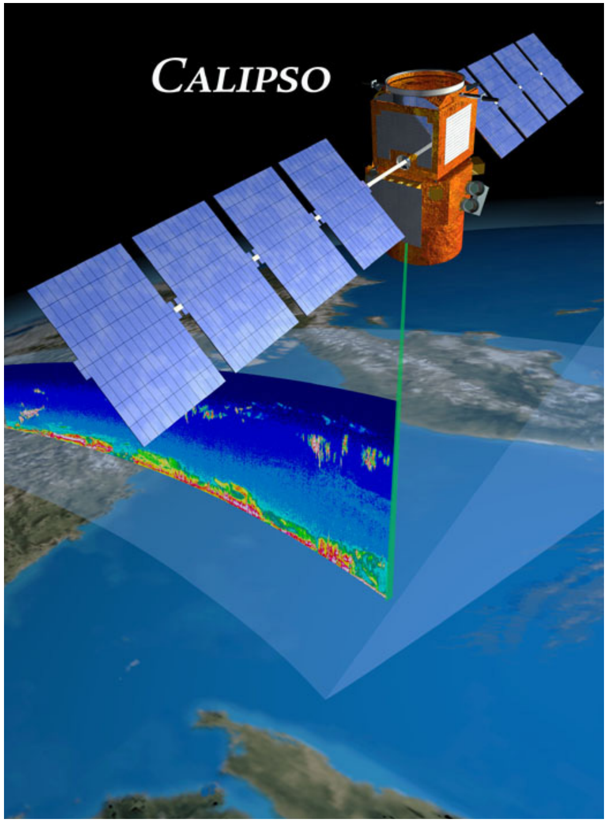
Raman (non–elastic) LIDAR
under development
in collaboration with IFAE/Barcelona
for CTA

dynamic range increases
$1:600 \rightarrow 1:10^6$
increased stability

cta
cherenkov telescope array

LUPM
LABORATOIRE MONTPELLIER
UNIVERS & PARTICULES

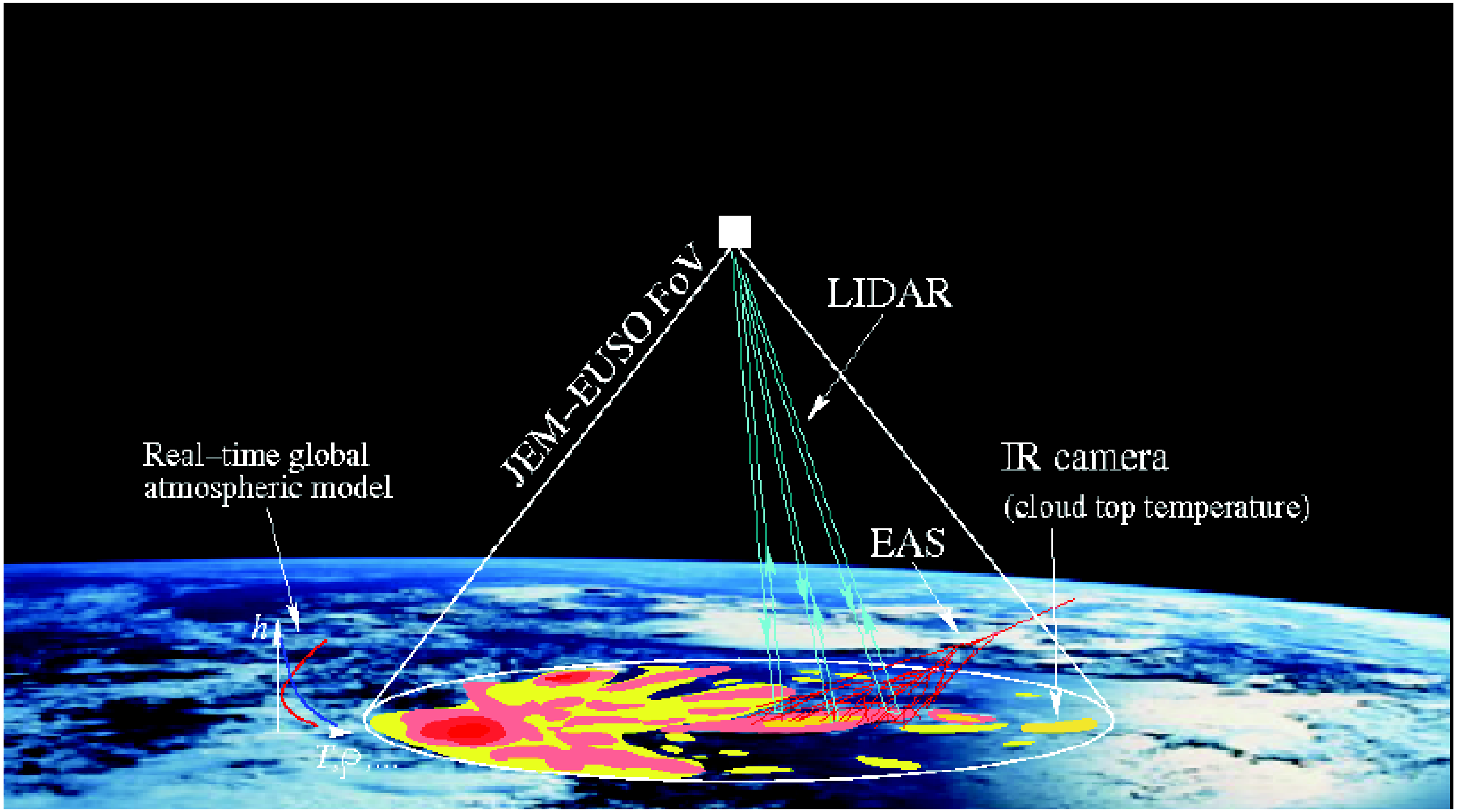




Complementary monitoring via satellite?

Low spatial resolution,
some difficulty <= 2 km altitude,
but:
consistent monitoring,
large database,
good sensitivity to clouds & aerosols,
free

Not just IACTs, Auger, also **JEM−EUSO**
its own suite of atmospheric monitoring instruments



R&D in previous generation of instruments →

Validation/integration in current generation of instruements →

Standard calibration in next generation of instruments

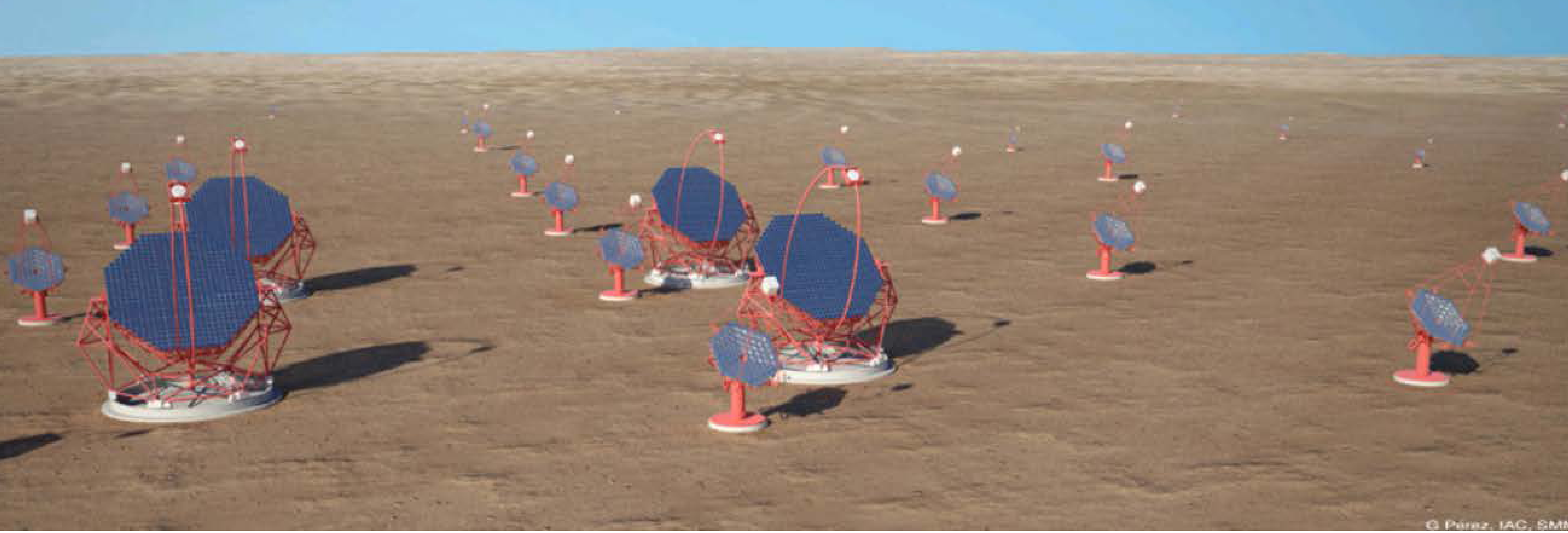
Expertise coming together for CTA (& JEM–EUSO)
namely from Auger, H.E.S.S., & MAGIC

French participation (LUPM & LPSC) quite modest
but very active & visible internationally

cta
cherenkov telescope array

Typical systematics breakdown for current−generation IACTs

Uncertainty	Flux
MC Shower interactions	1%
MC Atmospheric sim.	10%
Broken pixels	5%
Live time	1%
Selection cuts	8%
Background est.	1%
Run-by-run variability	15%
Data set variability	-
Total	20%



Increased exposure
Increased sensitivity
Increased statistics

→ Systematics dominated

cta
cherenkov telescope array

AtmoHEAD

AtmoHEAD Organizing Committee

Ryan C. G. CHAVES	Chair, CEA/SAp/AIM*
Yves GALLANT	CNRS/LUPM
Karim LOUEDEC	CNRS/LPSC
Mathieu DE NAUROIS	Ecole Polytechnique/LLR
Fabian SCHUESSLER	CEA/SPP
Thierry STOLARCZYK	CEA/SAp/AIM
George VASILEIADIS	CNRS/LUPM

** now CNRS/LUPM*

AtmoHEAD

Visibility

Widely announced in community

CTA, Pierre Auger, H.E.S.S., MAGIC, VERITAS, Telescope Array, HAWC, JEM-EUSO, JEM-Balloon, LSST

Web presence

https://indico.in2p3.fr/event/AtmoHEAD

Poster & logo:

CEA/IRFU graphic design intern & OC

AtmoHEAD

Diversity

Inscrits actuels (50)

nom	institution	Poste	ville	pays/région
Dr. BALKANSKI, Yves	CEA	researcher	91191 Gif sur YVETTE Cedex	FRANCE
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Dr. BLANC, Guillaume	APC	MCF	Paris	FRANCE
BOUCAUD, Alexandre	APC, Paris 7	Graduate Student	Paris	FRANCE
Dr. BREON, Francois-Marie	CEA/LSCE	Researcher	Gif sur Yvette	FRANCE
Mr. BUSCEMI, Mario	INFN of Naples and University of Naples	PhD student	Naples	ITALY
CHALMÉ-CALVET, Raphaël	LPNHE	PhD student	Paris	FRANCE
Dr. CHAVES, Ryan	CEA/SAp		Gif-sur-Yvette	FRANCE
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Mr. COLOMBI, Joshua	LPSC, CNRS/IN2P3, UJF-INPG	Stagiare	Grenoble	FRANCE
CONNOLLY, Michael	NUI Galway	student	Galway	IRELAND
Dr. DANIEL, Michael	University of Liverpool	Research Associate	Liverpool	UNITED KINGDOM
DORO, Michele	University of Padova and INFN	Post-doc	Padova	ITALY
Dr. GALLANT, Yves	LUPM, CNRS/IN2P3, U. Montpellier 2	Chargé de recherche (CNRS)	Montpellier	FRANCE
Mr. GARRIDO TERRATS, Daniel	Universitat	PhD Student	Bellaterra	SPAIN

50
participants

13
countries

8
international
collaborations

Bachelor student
Master students
Ph.D. students
post−docs
tenured researchers

AtmoHEAD Posterity: Presentations archived

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Support

ryan.chaves@univ-mo...

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Displaying **37** contributions out of **37**

ARCADE – Atmospheric Research for Climate and Astroparticle Detection

Type: Talk **Session:** Tuesday afternoon **Track:** Monitoring facilities under development

The characterization of the optical properties of the atmosphere in the near UV, in particular the tropospheric aerosol stratification, clouds optical depth and distribution are common to the field of the physics of the atmosphere, due to aerosol effect on climate, and also to the physics of cosmic rays, for a correct reconstruction of energy and longitudinal development of showers. The goal of t ... More

Presented by **Mario BUSCEMI** on **11 Jun 2013** at **16:45**

Aerosol characteristics at VERITAS

Type: Talk **Session:** Monday morning **Track:** Monitoring facilities in operation

The stereoscopic Imaging Atmospheric Cherenkov Telescope array of VERITAS, situated at the F.L. Whipple Observatory administrative complex at the foot of the Santa Rita Mountains in southern Arizona, operates in the energy range between 100 GeV and 30 TeV. The VERITAS collaboration engages in wide-ranging scientific and observational programs in the areas of galactic and extra-galactic gamma-r ... More

Presented by **M. Michael CONNOLLY** on **10 Jun 2013** at **12:10**

Aerosol concentration measurements and analysis of air mass backward trajectories at the Pierre Auger Observatory

Type: Poster **Session:** Poster session **Track:** Poster contributions

Aerosols play an important role in the attenuation of UV fluorescence light originated when cosmic rays cross the atmosphere, interacting with the atmospheric nitrogen molecules. This light is recorded by the fluorescence detector (FD) of the Pierre Auger Observatory (www.auger.org), composed of 27 telescopes distributed in 4 stations. In one of these stations, named Coihueco (35° 06′ 52.9′� ... More

Presented by **Dr. Karim LOUEDEC** on **11 Jun 2013** at **15:25**

Aerosol effect on multiple scattering for light propagation in the atmosphere

Type: Talk **Session:** Monday afternoon 2 **Track:** Simulations, modeling, and reconstruction

When cosmic rays enter the atmosphere, they induce extensive air showers composed of secondary particles. Charged particles excite atmospheric nitrogen molecules, and these molecules then emit fluorescence light in the 300-400 nm range. In cosmic ray observatories as the Pierre Auger Observatory or Telescope Array, the atmosphere is used as a giant calorimeter, where the fluorescence light is prop ... More

Presented by **M. Joshua COLOMBI** on **10 Jun 2013** at **17:30**

AtmoHEAD Thematic organization

Track 1: Monitoring facilities in operation

Track 2: Simulations, modeling, & reconstruction

Track 3: Monitoring facilities under development

Track 4: Aerosols & interdisciplinary studies

Special Seminar

Interdisciplinary keynote

Poster contributions

AtmoHEAD Posterity: Proceedings arXived

arXiv:1403.4816 [html]

AtmoHEAD 2013 workshop / Atmospheric Monitoring for High-Energy Astroparticle Detectors

K. Bernlöhr, G. Bellassai, O. Blanch, M. Bourgeat, P. Bruno, M. Buscemi, C. Cassardo, P.M. Chadwick, R. Chalme-Calvet, F. Chouza, M. Cilmo, M. Coco, J. Colombi, M. Compin, M.K. Daniel, R. De Los Reyes, J. Ebr, R. D'Elia, C. Deil, A. Etchegoyen, M. Doro, S. Ferrarese, M. Fiorini, LL. Font, D. Garrido, H. Gast, M. Gaug, F. Gonzales, A. Grillo, F. Guarino, J. Hahn, M. Hrabovsky, K. Kosack, P. Krüger, G. La Rosa, G. Leto, Y.T.E. Lo, A. López-Oramas, K. Louedec, M.C. Maccarone, D. Mandat, V. Marandon, E. Martinetti, M. Martinez, M. de Naurois, A. Neronov, S.J. Nolan, L. Otero, M. Palatka, J. Pallotta, M. Pech, G. Puhlhofer, M. Prouza, E. Quel, D. Raul, P. Ristori, M.D. Rodriguez Frias, S. Rivoire, C.B. Rulten, P. Schovanek, A. Segreto, G. Sottile, L. Stringhetti, J.-P. Tavernet, et al. (9 additional authors not shown)

Comments: Proceedings of the Atmospheric Monitoring for High-Energy Astroparticle Detectors (AtmoHEAD) Conference, Saclay (France), June 10-12, 2013

Subjects: **Instrumentation and Methods for Astrophysics (astro-ph.IM)**; High Energy Astrophysical Phenomena (astro-ph.HE); High Energy Physics - Experiment (hep-ex); Atmospheric and Oceanic Physics (physics.ao-ph)

Contents

18 proceedings published
provide excellent snapshot of state of the field in 2013

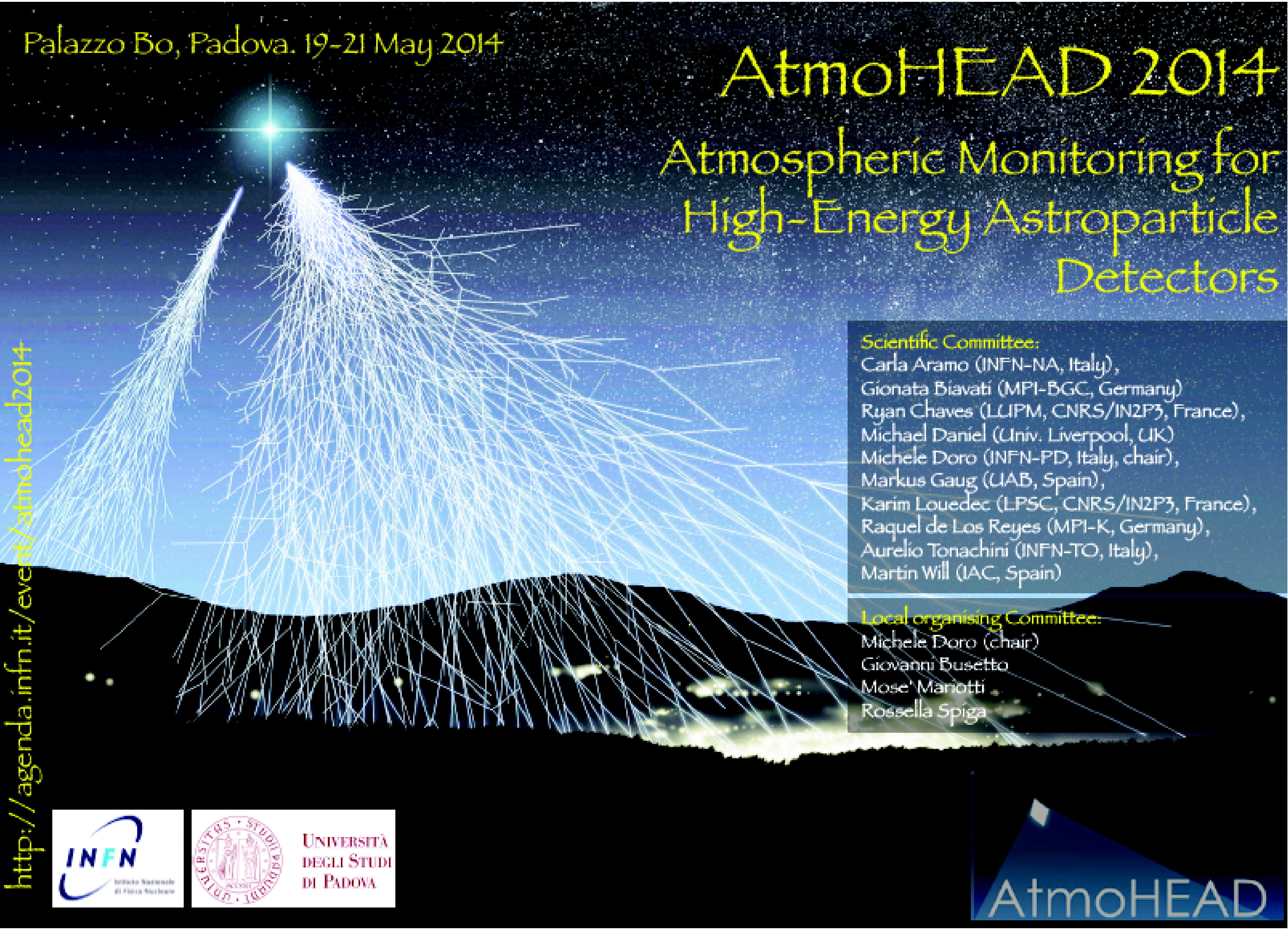
AtmoHEAD Workshop series

Thematic successor to:

AA	2003	Paris
ATMON	2008	Prague
ATMON	2010	Madison

Rebooted workshop series started:

AtmoHEAD	2013	Saclay
AtmoHEAD	2014	Padova



Palazzo Bo, Padova. 19-21 May 2014
AtmoHEAD 2014
Atmospheric Monitoring for High-Energy Astroparticle Detectors
Scientific Committee:
Carla Aramo (INFN-NA, Italy),
Gionata Biavati (MPI-BGC, Germany)
Ryan Chaves (LUPM, CNRS/IN2P3, France),
Michael Daniel (Univ. Liverpool, UK)
Michele Doro (INFN-PD, Italy, chair),
Markus Gaug (UAB, Spain),
Karim Louedec (LPSC, CNRS/IN2P3, France),
Raquel de Los Reyes (MPI-K, Germany),
Aurelio Tonachini (INFN-TO, Italy),
Martin Will (IAC, Spain)
Local organising Committee:
Michele Doro (chair)
Giovanni Busetto
Mose' Mariotti
Rossella Spiga
http://agenda.infn.it/event/atmohead2014
INFN
Istituto Nazionale di Fisica Nucleare
Università degli Studi di Padova
AtmoHEAD

Merci

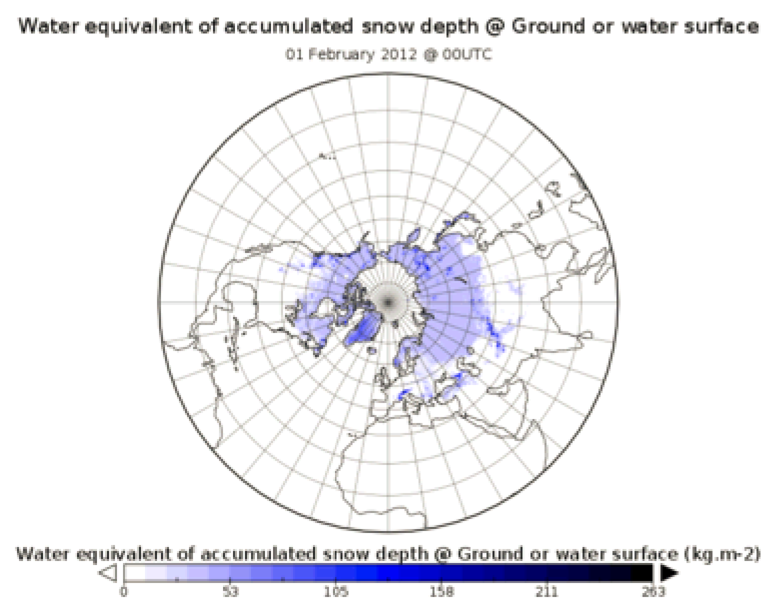
Backup

GDAS

NOAA NATIONAL CLIMATIC DATA CENTER
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Global Data Assimilation System (GDAS)

The Global Data Assimilation System (GDAS) is the system used by the Global Forecast System (GFS) model to place observations into a gridded model space for the purpose of starting, or initializing, weather forecasts with observed data. GDAS adds the following types of observations to a gridded, 3-D, model space: surface observations, balloon data, wind profiler data, aircraft reports, buoy observations, radar observations, and satellite observations. GDAS data are available through NOMADS as both input observations to GDAS and gridded output fields from GDAS. Gridded GDAS output data can be used to start the GFS model. Due to the diverse nature of the assimilated data types, input data are available in a variety of data formats, primarily Binary Universal Form for the Representation of meteorological data (BUFR) and Institute of Electrical and Electronics Engineers (IEEE) binary. The GDAS output is World Meteorological Organization (WMO) Gridded Binary (GRIB).

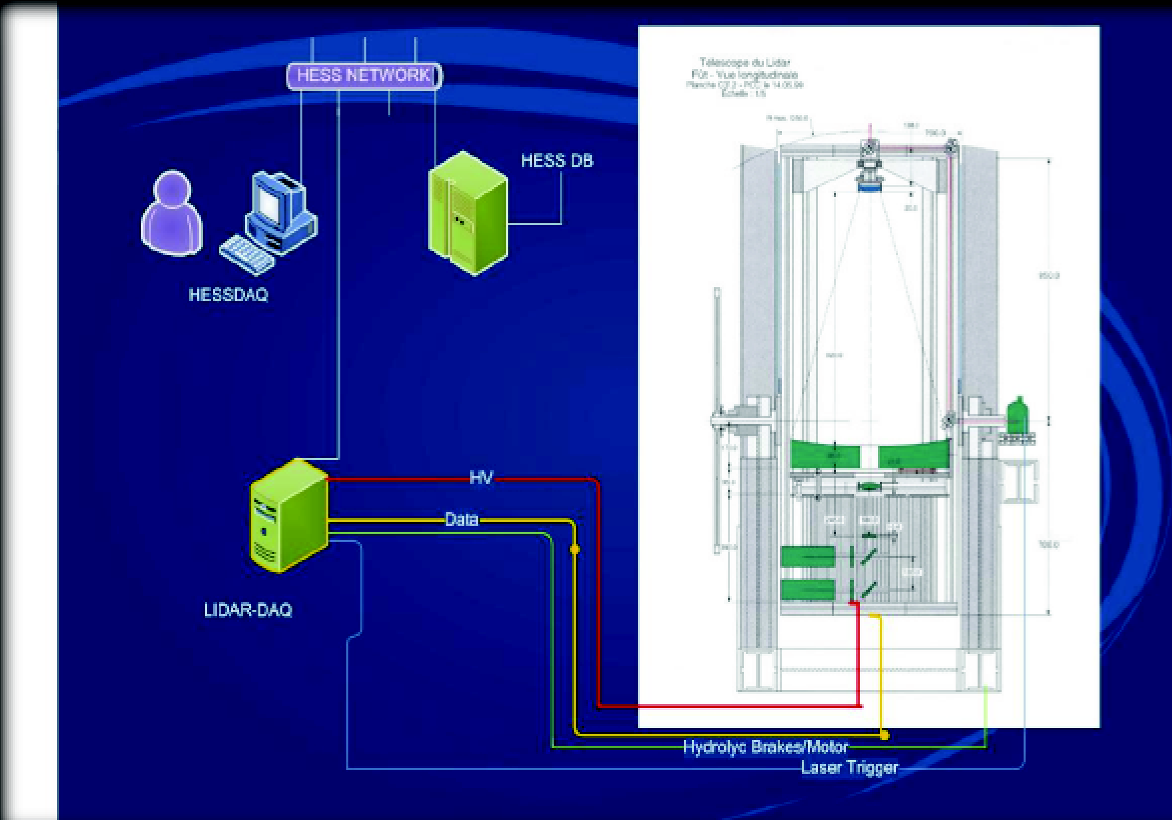


A plot of GDAS output showing the amount of water in snow covering the ground on February 1st, 2012 at 00UTC. This image was produced by visualizing GDAS output data with NASA's Panoply visualization tool.

LUPM LIDAR

LIDAR SPECIFICATIONS

- Elastic Lidar
- Biaxial/Coaxial Configuration
- Quantel Brillant 30
  - 355 nm
  - 532nm
  - 10Hz
  - 3.4W
- 60 cm mirror
- f1.4
- Cassegrain telescope
- PMTs readout
- Zenith-3^{o} pointing fixed
- Fully automated
  - Shift mode
  - Standalone mode



G. Vasileiadis